ALASKA SURF CLAM SURVEY IN THE EASTERN BERING SEA AND ALONG THE ALASKA PENINSULA, 1995: WITH A REVIEW OF PREVIOUS SURVEYS AND MANAGEMENT IMPLICATIONS

By

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INTRODUCTION

The Alaska surf clam, *Spisula polynyma*, is found in intertidal and subtidal waters of Alaska (Chamberlin and Stearns 1963). It has a reported range from Point Barrow, Alaska to the Strait of Juan de Fuca, Washington, generally occurring in medium grade sediments (Chamberlin and Stearns 1963). Very little is known about the biology of the Alaska surf clam. Specifically around the Alaska Peninsula, there has been three limited surveys conducted in 1977, 1978 (Hughes and Bourne 1981), and later in 1993 (Vining 1996). Research conducted from these surveys found the Alaska surf clam to be a long lived (25 years) and slow growing (K=0.135) species (Hughes and Bourne 1981). Research on Alaska surf clams from Prince William Sound found size at maturity to be 8 years of age and fully recruited to the commercial gear at age 9 (Feder et al. 1976).

Despite the uncertainties of the resource and limited biological data there is continued commercial interest in the Alaska surf clam resource in the Bering Sea. Although there is a paucity of information on Alaska surf clams, there is a closely related Atlantic surf clam (*Spisula solidissima*) that has an extensive historical fishery (dating back to 1870) from which some information or guidance may be drawn. However, caution applying management approaches conceived for the Atlantic surf clam to the Alaska surf clam are warranted due to unknown differences in the biology of the two species. Therefore, the objectives of this study were to (1) strengthen our understanding of the distribution of Alaska surf clams along the Alaska Peninsula and (2) review the development of the Atlantic surf clam fishery.

History of the Atlantic Surf Clam Fishery

Initial interest in Alaska surf clams parallels the decline of the Atlantic surf clam fishery (Hughes et al. 1977). The Atlantic surf clam fishery, similar to many shellfisheries, underwent periods of development, overcapitalization, collapse (Yancey and Welch 1968), and subsequent rebuilding (Murawski and Serchuk 1989). Atlantic surf clams occur in both state and federal waters along the Atlantic coast from Maine to North Carolina (NEFSC 1995). Prior to 1943 the Atlantic surf clams were harvested for bait (Lyles 1969). Between 1943 and 1949 the Atlantic fishery underwent several modernizations including processing techniques which made clams more desirable for human consumption (better cleaning) and development of a hydraulic dredge that increased harvests (Murawski and Serchuk 1989). In 1957 the fleet comprised nearly 100 small vessels, primarily owner-operated. However, by 1965 the fleet was reduced by half with a corresponding increase in vessel size and efficiency (Yancey and Welch 1968). By 1974 the fleet had once again increased to 100 vessels. Atlantic surf clam landings peaked in 1974 with 44 thousand tons and declined 49% by 1976 (Murawski and Serchuk 1989). Starting in 1977 federal waters were regulated under provisions of the Surf clam-Ocean Quahog Fishery Management Plan (MAFMC 1993). Beginning in 1978 annual quotas for harvest ranged from 13,880 mt in 1978-1981 to 21,706 mt in 1995. Increases in total allowable catch (TAC) resulted from improved resource conditions as well as a series of large year classes that spawned in the late 1970's (NEFSC 1995; Weinberg 1993). During 1977 through 1990 available fishing time was reduced to slow the overall catch rate and spread out the annual effort. Minimum shell lengths were also implemented: 5.5 inches in 1981-1984, 5.25 inches in 1985, 5 inches in 1986-1989, and 4.75 inches through the 1990's. Some concern was raised during 1981-1989 when discards of small surf clams were high. A study by Haskin and Starypan (1976), found that survival of discarded surf clams is approximately 50%. In 1991the Atlantic surf clam fishery in the EEZ moved to an individual transferable quata (ITQ) management system (NEFSC 1995). The Atlantic surf clam fishery was actually the first fishery to move to the ITQ system and there has been a number of economic studies demonstrating both the advantages and disadvantages of this system.

Prior Surveys of the Alaska Surf Clam

The decline in the Atlantic surf clam industry spurred interest in developing the Alaska surf clam resource in 1976 (Hughes et al. 1977). Declines in the Atlantic surf clam resource resulted in shortages of available clam meats as well as increases in exvessel prices. The population size and meat quality of the Alaska surf clam was unknown, which prompted an initial survey conducted by the National Marine Fisheries Service (NMFS). The survey was co-sponsored by Alaska Sea Grant, Food and Drug Administration, Alaska Department of Commerce, Alaska Department of Fish and Game, and the clam industry (contributing 70% of the budget).

1977 Survey

In 1977 NMFS conducted a survey of the Alaskan surf clam resource in the eastern Bering Sea and Alaska Peninsula (Hughes et al. 1977). The survey comprised two components: a wide cursory survey and a second more comprehensive survey of blocks where clams had been located in the first phase. The vessel used for the survey, *SMARAGD,* was a 96 foot West Coast vessel, outfitted with a East Coast style hydraulic clam dredge. The dredge used was 7 feet wide by 18 feet long, and weighed 13,000 pounds. The knife was 3 feet wide.

The study area for the first part of the survey was determined by examining data from the NMFS otter-trawl surveys that had been conducted between 1969 and 1976 (Appendix A.1). Grids were overlaid on trawl stations, then divided into quarters, where clams or clam shells had been collected. This resulted in 180 blocks each 100 square miles. Each block was to be sampled with a single tow of 10 to 30 minutes in duration. The second phase comprised many shorter tows located in blocks that were suspected to have high clam densities based on knowledge from phase I (Appendix A.3).

During Phase I the survey sampled 66 out of the 180 separate blocks identified (Appendix A.2). Densities were determined to be very low in offshore blocks, however, a possible clam resource was identified along the Alaskan Peninsula. Phase II of the study then concentrated along the Alaska Peninsula between Ugashik and Port Moller. Based on Phase II of this survey a biomass was estimated to be 286,184 metric pounds (95% confidence interval; 248,294 to 324,074 pounds). The researchers also identified a Tellin population of 82,000 metric tons. The highest surf clam catch rates were between 13 to 18 fathoms and peaking 15 to 16 fathoms.

1978 Survey

With the apparent success of the 1977 survey a second survey was conducted in 1978 to reaffirm the resource potential (Hughes and Nelson 1979). The study area was confined to the region where the clam resources had been identified in Phase II of the 1977 survey (Appendix A.3). During this survey 234 tows were completed. Estimated biomass based on this survey ranged from 248,000 to 324,000 metric tons (95% confidence interval).

Combined results from the 1977 and 1978 survey produced an estimated exploitable biomass of 329,000 (+/- 52,000) tons (Hughes and Bourne 1981). Average catch per unit of effort was estimated to be 815 kg/hr. From the estimated 329,000 tons the authors estimate an annual yield of 25,017 tons; based on a relationship between the exploitable biomass and the instantaneous mortality rate (Hughes and Bourne 1981).

1993 Survey

Based on the surveys conducted in the 1970's (Hughes and Nelson 1979, Hughes et al. 1977), the Alaskan Clam Corporation was interested in the Alaskan surf clam resource. In August 1993, the Alaskan Clam Corporation obtained a permit from the Alaska Department of Fish and Game to survey specific areas in the Bering Sea. The permit contained several provisions including a requirement for carrying an onboard observer (Vining 1996). The study was designed to take a closer assessment of two of the study blocks (50 and 57; Appendix A.4) identified in the 1977 survey as having high clam densities (Appendix A.3). The 22.86 m *R/V NORTHERN EXPLORER* with a 1.22 m wide surface hydraulic clam dredge was used to collect surf clams. Survey protocol specified tow time to be approximately 15 minutes, at a speed of about 3.7 kilometers per hour (kph). Survey locations within each sample block were randomly chosen. Based on this survey the density of surf clams in block 57 was 64.24 kg/ha (15.80 kg.ha standard error) and the density of surf clams in block 50 was 4.13 kg/ha (1.34 kg/ha standard error). All PSP tests resulted in levels safe for human consumption (Vining 1996). The prior surveys (1977 and 1978) estimated an average of 35,867 metric tons in block 50 and 48,091 metric tons in block 57. Converting to kilograms per hectare, block 50 had 1,427 kg/ha and block 57 had 1,856 kg/ha. Therefore there was a 1,792 kg/ha decrease in block 57 and a 1,423 kg/ha decrease in block 50 between the early survey (1977 and 1978) and the 1993 survey.

Current Survey

The current study is a follow-up to the survey conducted in 1993. Clam densities demonstrated in the 1993 survey, did not verify the promising results of the surveys conducted in 1977 and 1978. However, the study area of the 1993 survey was relatively small and it is possible the clam population distribution shifted. Therefore, the objectives of this survey were to cover a broader area along the Alaska Peninsula.

METHODS

The *R/V NORTHERN EXPLORER* (75' steel vessel) was given permission to conduct a survey along the Alaska Peninsula (north and south) and eastern Bering Sea; statistical area J between 54° 36 N. latitude, 57° 30 N. latitude, and between the longitude of 156° 19W (Kilokak Rocks) and 164° 44 W longitude (Scotch Cap light). In contrast to the 1993 survey, conducted by the same vessel, survey locations were not random (Figure 1). Surveyed areas were determined by the vessel operator, W. Kopplin, in locations suspected to have high clam densities, based on either prior knowledge or substrate type. The vessel was outfitted with a 48-inch hydraulic clam dredge. The vessel was given permission to survey between 20 June 1995 and 15 August 1995; however, the vessel only operated from June 22 through July 10^{th} , 1995. Through permit stipulations allowing for the survey, the vessel was required to contract a third party observer and the vessel operator was required to keep a log. The vessel log was to detail haul information: date, duration of tow, position, and depth. The observer was given instructions to collect haul by haul information detailing species composition, size frequency, mortality, and damage.

General protocol allowed for 15 minute tows after which the dredge was hauled onboard and the contents emptied on deck. If there were any problems with dredging at a specific location, it was noted on the vessel log.

Once the dredge contents were emptied on deck the observer was instructed to sort the catch by species. Each species was enumerated and weighed. Surf clams and commercially important crab were measured to the nearest mm. Crab were also sexed.

Data Analysis

Similar to the previous surveys, density of Alaska surf clams was the most important parameter. Unlike the previous surveys, abundance was not estimated because of the difference in sampling design. For comparison to the survey conducted in 1993, density was estimated in terms of catch per unit effort (CPUE). Catch per unit of effort was measured as weight in kilograms of an organism caught in a specific tow divided by the area in hectares covered during that tow. Correlations to other species were conducted to explore positive or negative species associations that may be affected by commercial claming. Descriptive statistics (sample size and mean) of surf clams, crab and cockles were performed. Density of surf clams was also estimated for statistical area to look for similarities in trends between the findings of the earlier surveys and this one. Dredge locations were plotted based on latitude and longitude from the skipper log.

RESULTS

The results from the 1995 survey tend to support the results from the 1993 survey (Vining, 1996) and contrasted with the results from the late 1970's surveys (Hughes et al.1977, Hughes and Nelson 1978, Hughes and Bourne 1981). A total of 629 kg of surf clams were caught during the survey out of 133 successful tows; or 4.7 kg per tow (Table 1). Average CPUE of intact surf clams was 27 kg/ha (Table 1). Average total (intact and broken) CPUE was 38 kg/ha. The highest densities of surf clams occurred in statistical areas 595632 and 605630 (Figure 2 & Table 2). These areas correspond to the same areas found to have high densities during the previous surveys; however, the densities are much lower than previously reported. Roughly, ¼ of the sampled statistical areas and 20% of all sampled tows were empty. Statistical areas 565633, 575603, 575631, 605534, 605535, 615531, 615532, 615601, and 615602 had an average CPUE of zero. The most common item caught were rocks and the most commonly encountered organisms were miscellaneous bivalves and scallops (Table 1). The least common species were red king crab (>1 CPUE; Table1). The species with the highest correlation to surf clams were Tellins (0.63), Sole (0.31), and miscellaneous bivalve species (0.52; Table 1). Mean height of surf clams was 91.86 mm (Figure 3). Mean height of different cockle species ranged from 65.5 mm to 85.86 mm (Table 3); however, some species had very few measurements. Red king crab length averaged 35.24 mm and Dungeness crab averaged 146.78 mm (Table 3).

Crab Bycatch

Surveys conducted during the late 1970's encountered 90 king crab in 12.2 hours of fishing in the Bering Sea (depth of 12-32 fathoms) and 33 king crab in 30.2 hours of fishing along the Alaska Peninsula (depth of 10-22 fathoms; Hughes et al. 1977). The survey conducted in 1993 did not encounter Tanner or king crab during the survey (Vining 1996). The 1995 survey caught 24 Dungeness and 62 red king crab incidental to the surf clams; however, CPUE and percent occurrence for both species was low (Table 1). The majority of the red king crab (89%) were caught in a single tow in statistical area 605602. The Dungeness crab were caught in statistical areas 565632, 595531, and 605506. Based on the length data, the red king crab were immature; however, the mean length for the Dungeness crab was very close to the legal harvestable size (Table 3).

Management Implications

Atlantic Surf Clams

The National Marine Fisheries Service (NMFS) utilizes periodic surveys (e.g. 20 surveys between 1965 and 1994) to evaluate distribution, relative abundance, and size composition of Atlantic surf clams. The natural mortality rate (M) has been assumed to be 0.05 with full recruitment to the fishery at age 5 (Murawski and Serchuk, 1989). Fishing mortality rates have ranged from 0.12 to 0.23 in the New Jersey area and 0.09 to 0.24 in the Delmarva region (MAFMC 1993). Assessment of the Atlantic surf clam resource utilizes an integrated modified DeLury model (Conser and Idoine 1992) incorporating both survey information as well as catch data. Supply years is then modeled as a function of harvest levels and recruitment scenarios (NEFSC 1996). In 1991, management of the Atlantic surf clam resource moved to an ITQ system. As a result of moving to the ITQ system the number of participating vessels has decreased considerably and average fishing time has increased (MAFMC 1993).

Alaska Surf Clams

Despite four surveys of the Alaska surf clam resources, very little is known about the biology, distribution, and current population status of this species. The contrasting results from the 2 pairs of studies, early (Hughes et al. 1977; Hughes and Nelson 1978) and late (Vining 1996 and the current study) make prognosis of the population status very difficult.

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Table 1. Catch, density, percentage of occurrences (number of tows organism captured divided by 133 successful tows), and correlation of occurrence (to surf clams) of organisms and rocks during the 1995 Alaska surf clam survey along the Alaska Peninsula and Eastern Bering Sea.

Organism	Total Catch (kg)	Average (CPUE) (Kg/ha)	Occurrence (%)	Alaska surf clam correlation
Alaska surf clams (intact only)	459	27	49	0.98
Alaska surf clams (total)	629	38	56	1.00
Starfish	99	9	30	-0.04
Tellins	215	12	27	0.63
Hermit Crabs	8	1	12	0.25
Sole[a]	14	1	14	0.31
Dungeness Crab	13	1	8	-0.08
Red King Crab	3	>1	3	-0.02
Cockles[b]	5	2	11	-0.07
Scallops[c]	4,167	329	54	0.52
Rocks	21,684	5,164	72	-0.12
Miscellaneous[d]	203	21	46	0.16

[a] Includes flathead sole (*Hippoglossoides elassodon*), rock sole, (*Pleuronectes bilineatus*), and yellow sole (*Pleuronectes asper*).

[b] Includes Nuttalle's cockle (*Clinocardium nuttalli*), Greenland cockle (*Serripes groenlandicus*), and North Pacific cockle (*Clinocardium californiense*).

[c] Includes unidentified bivalve species.

[d] Includes decorator crab, lyre crab, unidentified snail spp, *Astarte* spp., *Protothaca* spp., *Yoldia* spp., sand worms, *Macoma* spp., *Cardita* spp., sandlance, *Hiatella* spp., and *Panomya* spp.

Table 2. Surf clam density (catch per unit of effort), by statistical area, from the 1995 surf clam survey.

Statistical Area	Sample Size	Average CPUE (kg/ha)
565633	8	0.0
575603	1	0.0
575631	4	0.0
575632	18	12.5
585631	7	17.3
585701	6	29.3
595531	7	4.8
595631	13	41.5
595632	20	132.0
605506	2	14.4
605534	2	0.0
605535	2	0.0
605601	14	54.9
605602	2	13.1
605630	4	126.1
615531	6	0.0
615532	5	0.0
615601	6	34.4
615602	1	0.0
625437	3	0.0
625502	4	3.3
635503	6	1.7
635504	5	10.5

Table 3. Mean length (mm) of other commercially important species.

	Sample Size	Mean length (mm)
Nutall's Cockle	21	80.86
N. Pacific Cockle	2	65.5
Greenland Cockle	7	85.86

	Males		Females		Total	
	Sample Size	Mean length (mm)	Sample Size	Mean length (mm)	Sample Size	Mean length (mm)
Red King Crab	32	34.81	30	35.7	62	35.24
Dungeness Crab	14	153.43	9	136.44	23	146.78

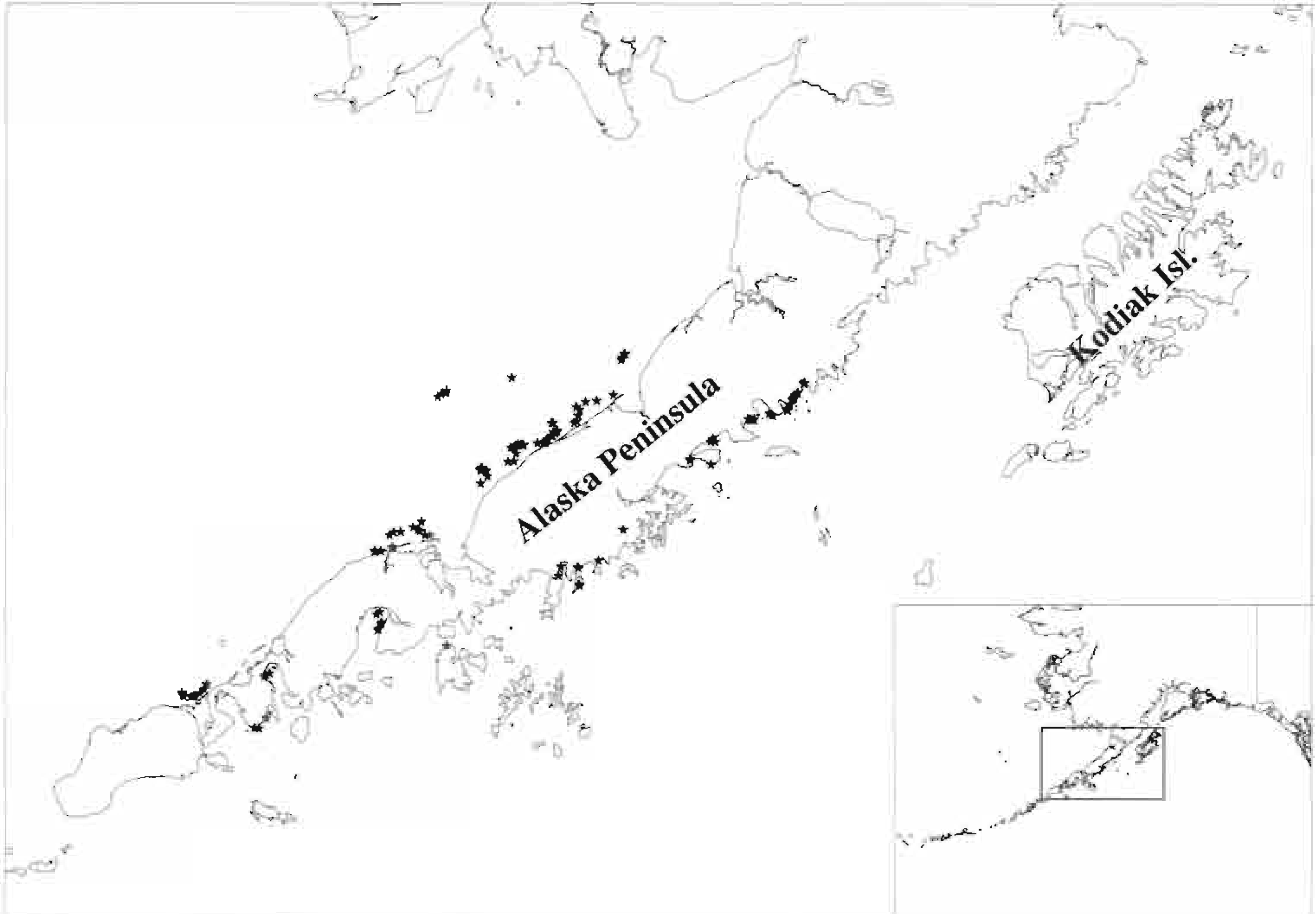


Figure 1. Survey locations along the Alaska Peninsula for the Alaska surf clam, 1995.

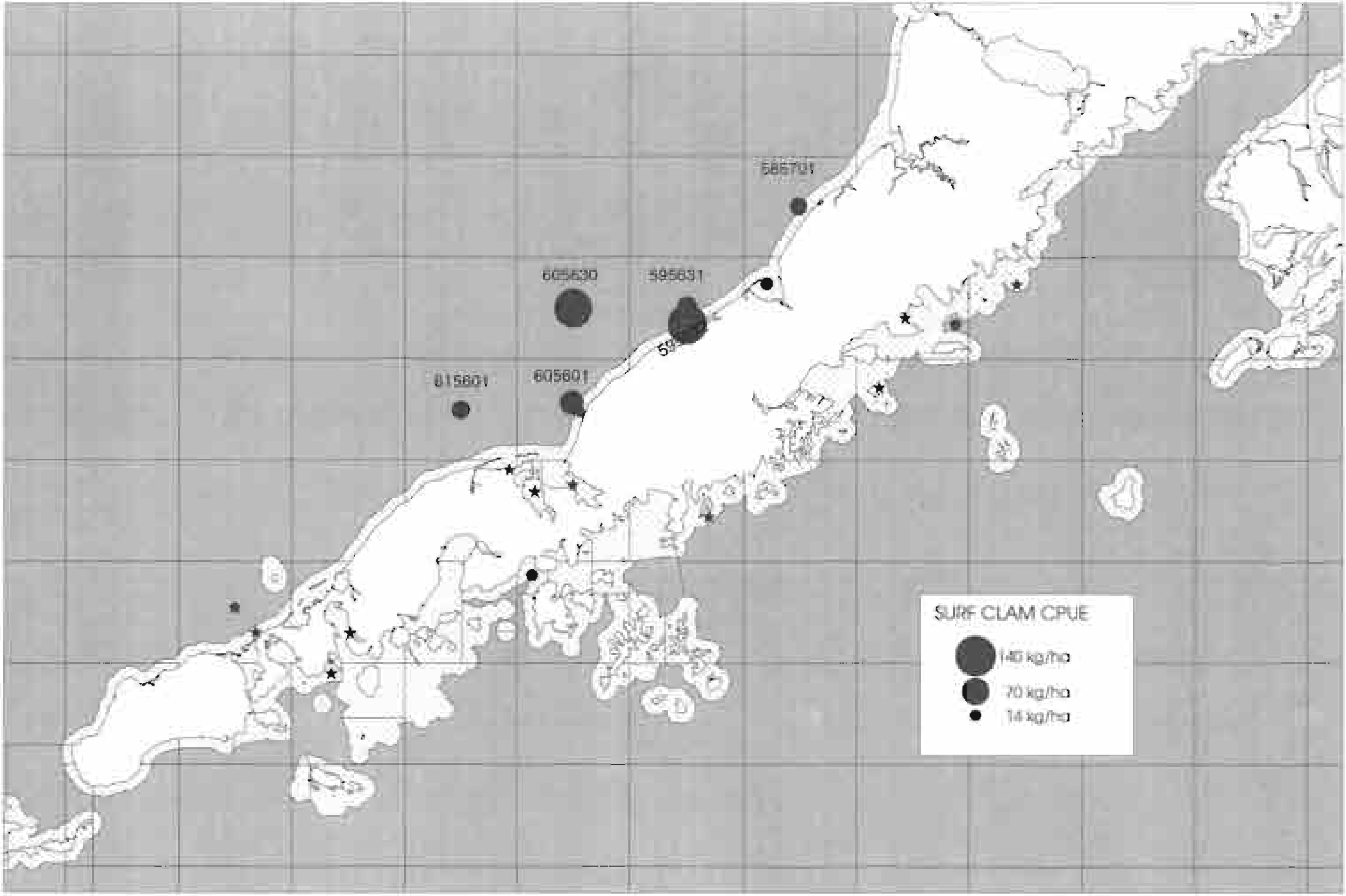


Figure 2. CPUE by statistical area for the 1995 Alaska surf clam survey. Higher densities are indicated by larger dots. Dots are at the center of the statistical area where the sample occured.

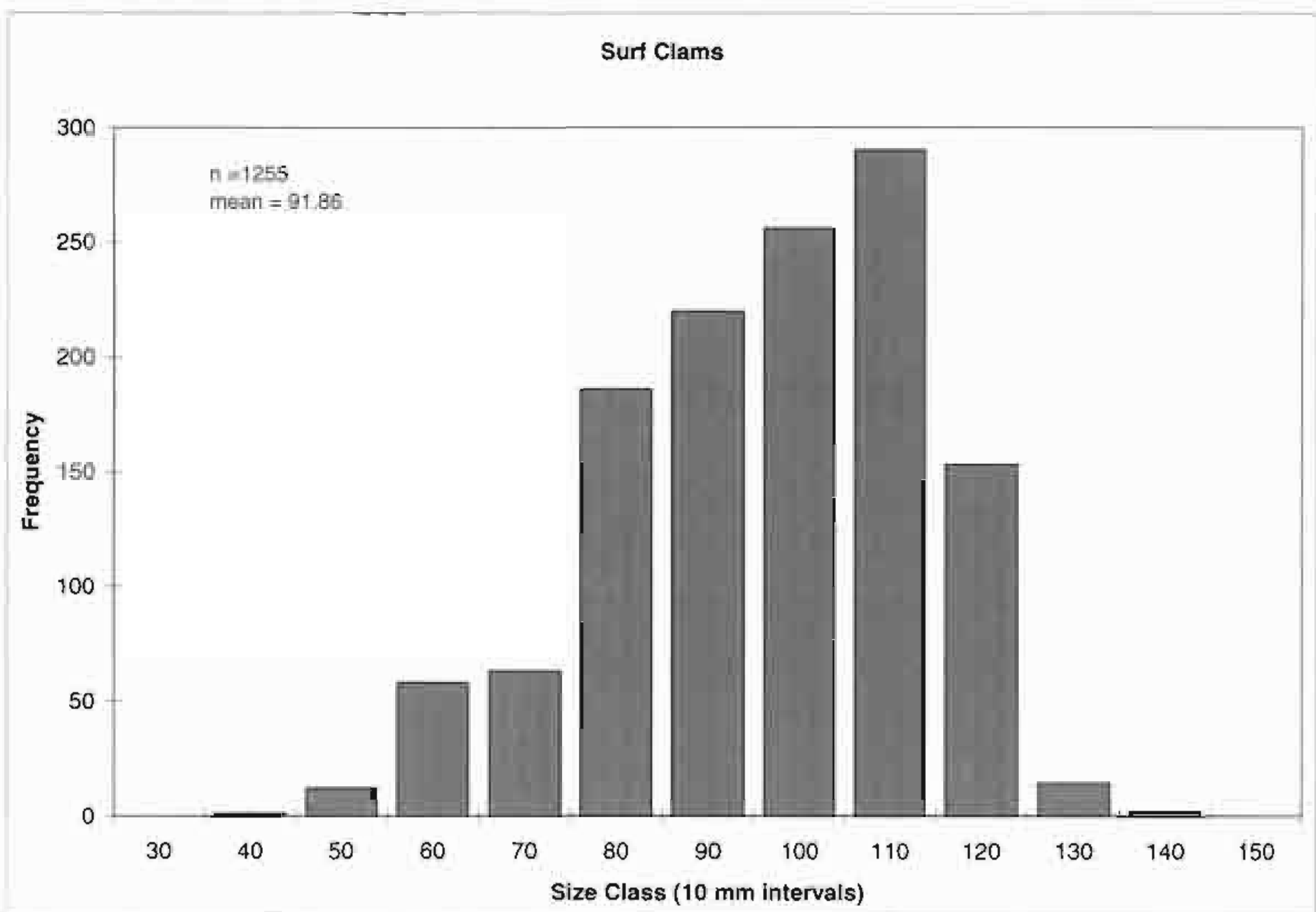
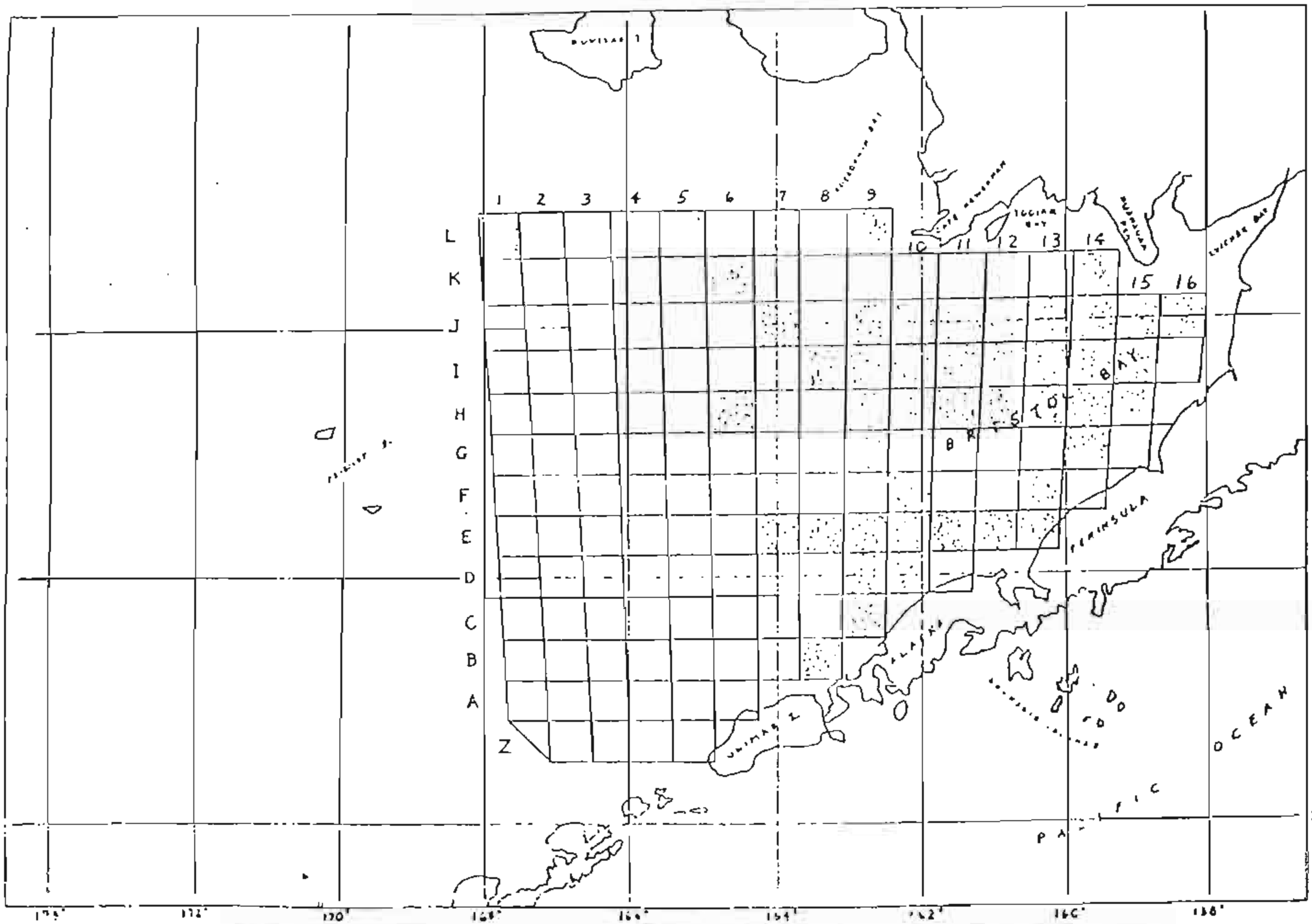
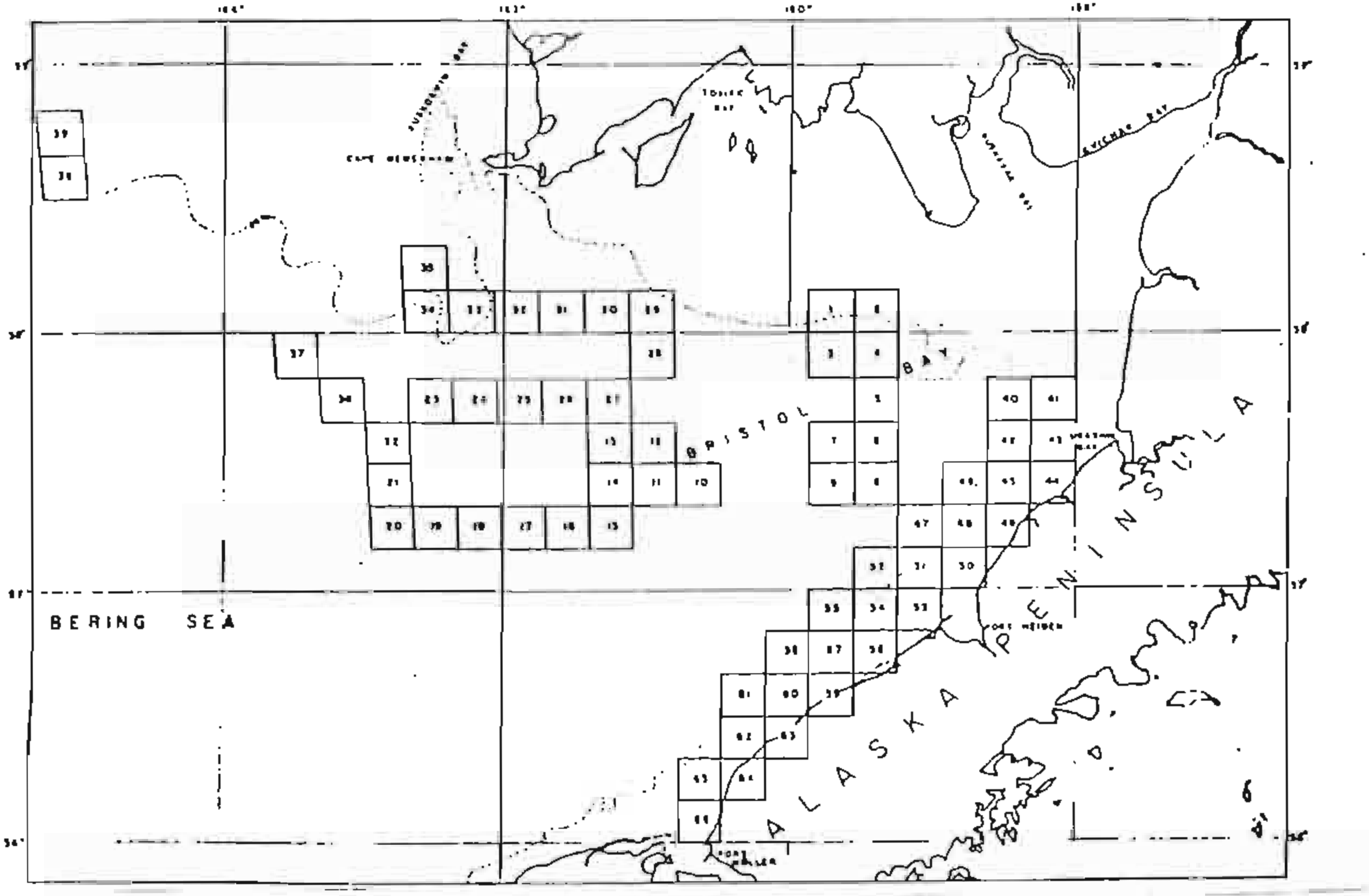


Figure 3. Histogram of surf clam lengths (mm) from the 1995 survey along the Alaska Peninsula and in the eastern Bering Sea.

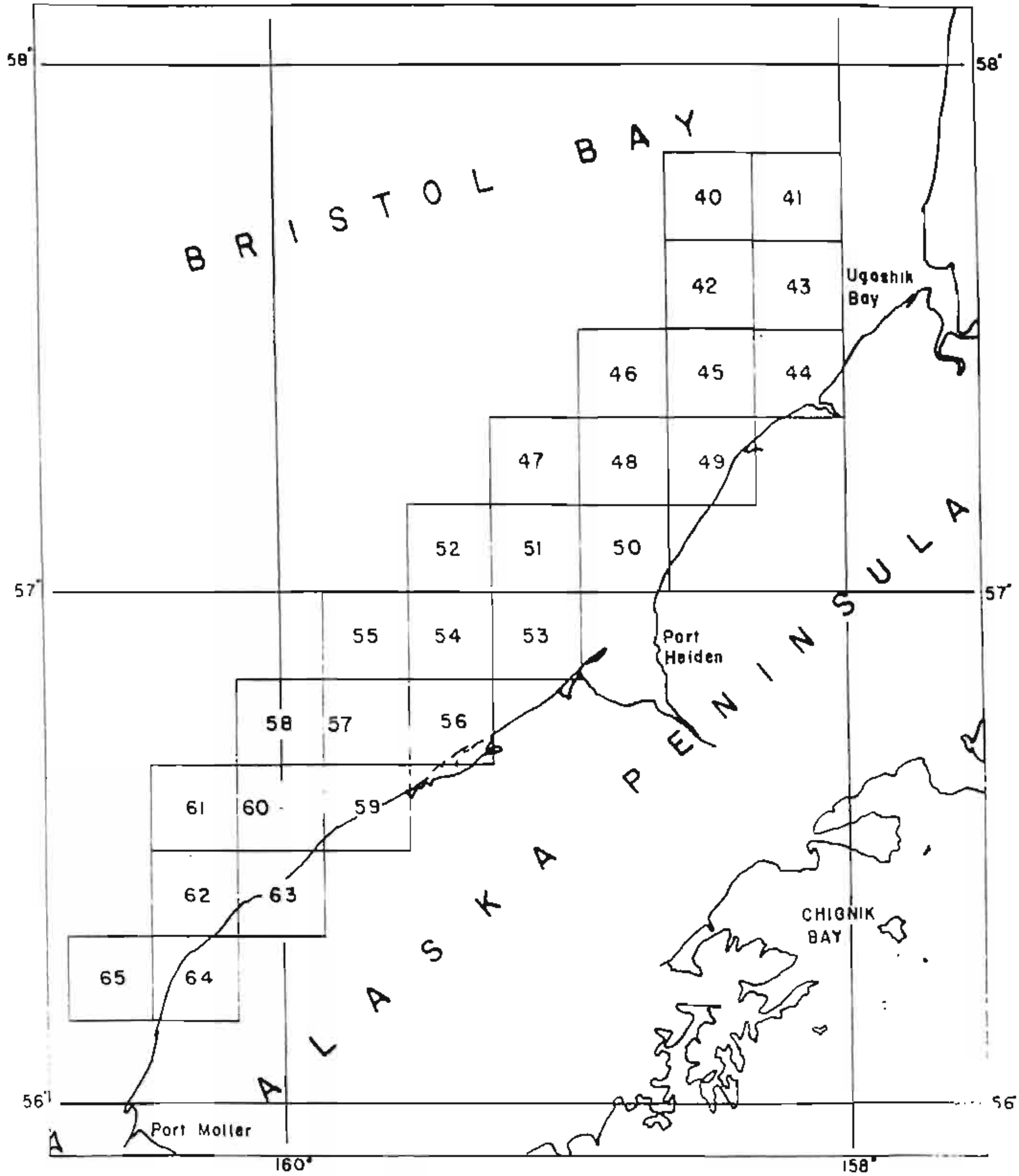
APPENDIX



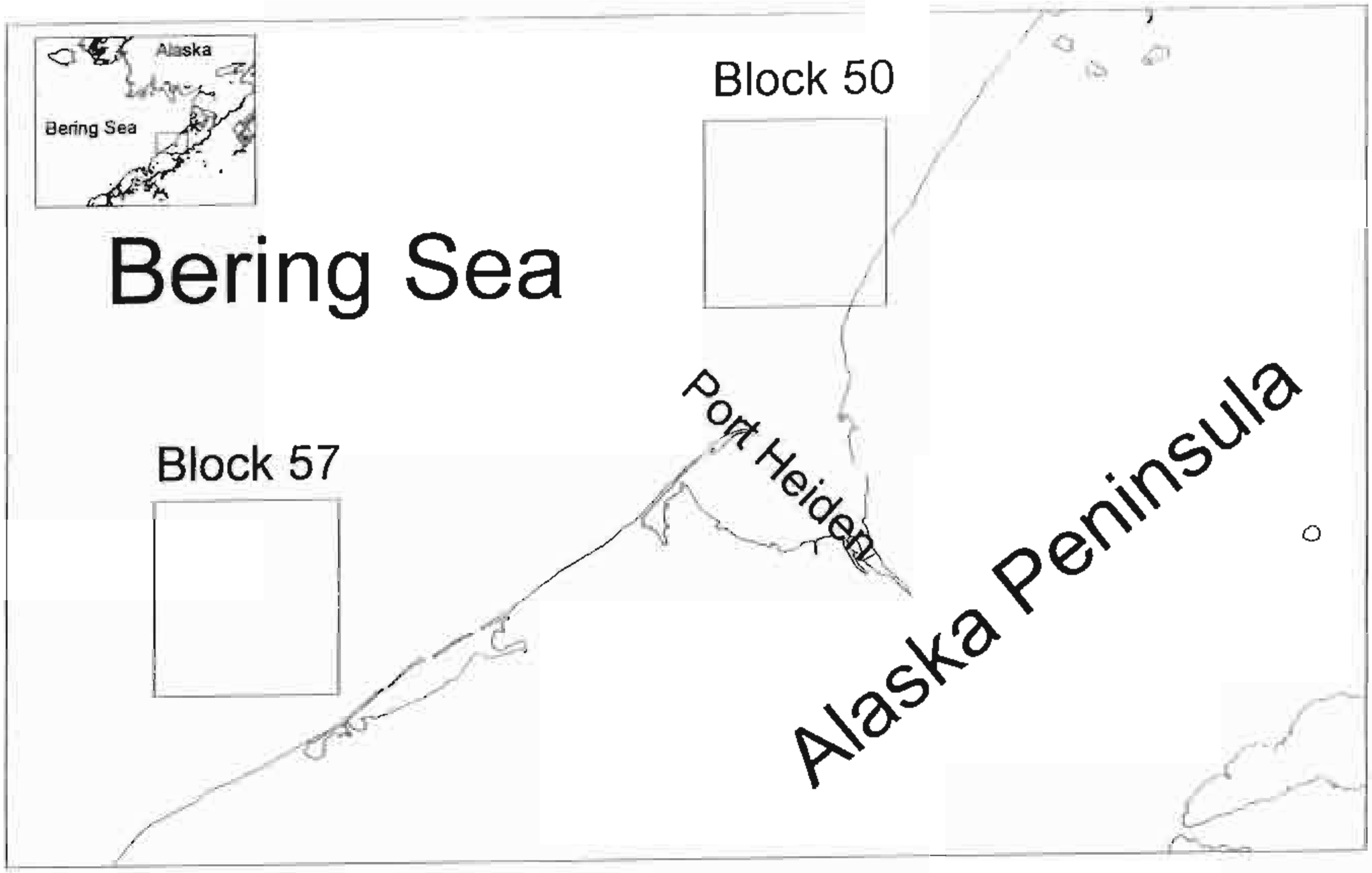
Appendix A.1. NMFS Bering Sea trawl survey pattern showing location of 400 square mile areas (shaded) where Alaska surf clams or their shells were obtained in the 1969-76 otter trawl surveys (adopted from Hughes et al. 1977).



Appendix A.2. Location of 66-100 square mile blocks in the southeastern Bering Sea where the 1977 subtidal clam resource assessment survey was conducted (adopted from Hughes et al. 1977).



Appendix A.3. Location of 13 sites in the Alaska Peninsula survey area where production-fishing studies (1977, phase II) on Alaskan surf clams were completed (Adopted from Hughes and Nelson 1979).



Appendix A.4. Location of the two sampled blocks during the 1993 Alaska surf clam survey (Adopted from Vining 1996).